

**ENGG1100 Introduction to Engineering Design**  
**Faculty of Engineering**  
**The Chinese University of Hong Kong**

**Introduction**

Week 1 (Sep. 2, 2013)

*Welcome to CUHK Faculty of Engineering and ENGG 1100!*

The objective of this course is to let you understand what engineering design is. A project-based learning method is adopted. In the project, you will learn to design and build an **Automated Guided Vehicle (AGV)**<sup>1</sup> that runs on a preset route to move an object from one place to its designated location. It may sound very challenging to people with little backgrounds in electronic circuit. Therefore, this course is designed in a way that students, with or without hardware background, will be guided step by step to reach the goal. The designed element will be more on the simple programming part of the car control module. The AGV should be designed to trace a magnetic strip, and a simple gripper will be used to fetch and release an object, e.g. a soda can. Both the mechanical parts and electronic hardware will be developed by you and your partner. Relax! Actually some premade boards will be given to you to reduce your workload. The lectures and laboratories are designed so as to equip you with the essential knowledge to build the AGV in a systematic way and successfully accomplish the task.

To smoothly carry out the project, you are expected to

- *attend BOTH the lectures and the laboratories in which you will learn the basic and essential knowledge for designing and implementing your AGV;*
- *identify and understand design constraints and requirements;*
- *define the milestones for accomplishing the task;*
- *communicate and collaborate with your partner effectively to carry out the project;*
- *build the AGV and demonstrate its performance for the specific tasks;*
- *submit a final report at the end of the term.*

In addition, for Lab 1 on mechanical design, you will learn basic mechanical drawing and design skills for a number of simple tasks. By submitting your designs to the 3D printer located in each department, you can experience *fast prototyping* via a 3D printer, which is a rising-star technology that will have tremendous impact in different fields, including engineering and life science (e.g. organ printing).

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<sup>1</sup> [http://en.wikipedia.org/wiki/Automated\\_guided\\_vehicle](http://en.wikipedia.org/wiki/Automated_guided_vehicle)

# 1 Project Description

The purpose of the project is to let you experience how an engineer solves a technical problem. In particular, you will be provided the necessary components to build a motorized robot car and the testing environment. The objective of the project is to ask the robot, a mini AGV, to move from a starting point, detect and pick up an object and bring it to the destination autonomously.

As shown in Figure 1a, the robot uses the magnetic sensors (S1, S2) facing the ground direction to detect the magnetic strip that defines the path for finding the target object. Another sensor S3 facing the front direction for detecting the target object is shown in Figure 1c.

The testing environment (Figure 2a) is a 60cm x 60 cm testing paperboard with magnetic strips placed underneath. The robot should begin at "Start"; follow the path defined by the magnetic strips using sensors S2 and S1, then detects the target object at "Target object position" using sensor S3. Finally, the robot will pick up the object and delivery it to "Destination"

Your job is to build and program the robot. In addition, you also need to design and assemble the testing board by placing the magnetic strip in the correct positions to define the target-searching path. The necessary skills for making the robot and the testing board will be taught in experiments 3-6.

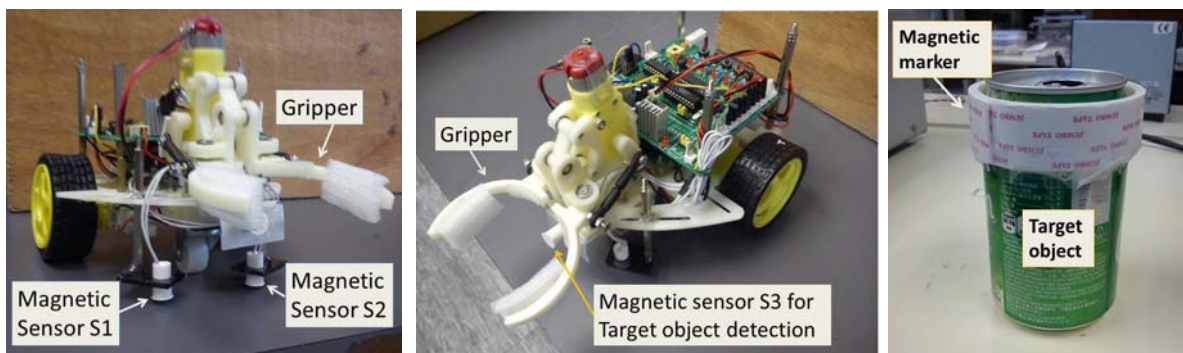


Figure 1a

1b

1c

The robot with sensors 1 & 2

Sensor S3

A target object



Figure 2a

2b

2c

The testing board

Magnetic strips underneath the board

A Magnetic strip

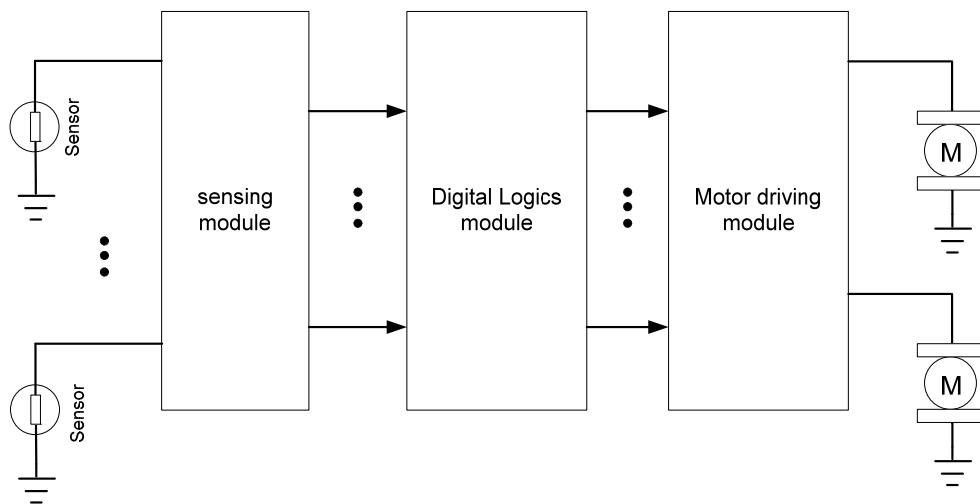


Figure 3: System diagram of the robot

The general system block diagram of the robot is shown in Figure 3. You are encouraged to bring your own ideas into the design and make the robot more intelligent. For the mechanical design, you will make accessories (e.g. gripper) using a software called SolidWorks and a 3D printer. In this course, you will be assigned a mentor (one of our professors) who will discuss with you on various aspects of the design; e.g., feasibility (i.e., is that doable?), robustness against different kinds of situations, and possible challenges and difficulties.

You may see the Video Demo of a sample car here:

<http://www.youtube.com/watch?v=zQgSbyl-A-k>

## 2 Course Schedule (\*\* REVISED \*\*)

Lecture : (except Week 1\*)

Class:	ENGG1100A	ENGG1100B
Time:	8:30am-9:15am	11:30am-12:15pm
Venue:	Lecture Theatre, 9/F, William MW Mong Engineering Building (ERBLT)	LT5, Lee Shau Kee Building (LSK LT5)

Lab: 9:30am -12:15pm (ENGG1100AL01/ AL02/ AL03)  
1:30pm-4:15pm (ENGG1100 BL01/ BL02)

Week	Date	Lecture	Lab session	Important Events
1	2/9	Introduction + Laboratory Safety		<ul style="list-style-type: none"> <li>● *1<sup>st</sup> lecture at 01:30pm at T.Y. Wong Hall (for both ENGG1100A and 1100B)</li> <li>● Project Grouping (via e-learning platform by Sep 6)</li> <li>● Release of <b>Mechanical Homework 1</b> (simple design for practical skills, e.g. a key ring)</li> </ul>
2	9/9	Mechanical Drawing	Workshop on Solid Works	
3	16/9	Engineering Design & Management + <b>Quiz information</b>	Lab 1: Mechanical Drawing	<ul style="list-style-type: none"> <li>● Release of project details/specification for midterm-demo</li> </ul>
4	23/9	<i>Class Suspension due to Typhoon</i>		<ul style="list-style-type: none"> <li>● Deadline of Mechanical Homework</li> <li>● Release of <b>Mechanical Homework 2</b> (gripper/sensor holder)</li> </ul>
5	30/9	Basic Electronic Circuits and Instrumentation (1)	Lab 2: Basic Electronics (1)	
6	7/10	Sensing and actuator	Lab 3: Basic Electronics (2) (soldering)	<ul style="list-style-type: none"> <li>● Preparation of quiz (1)</li> <li>● Release of Project materials (basic chassis + motors + wheels)</li> </ul>
7	14/10	No class (Chung Yeung Festival)		<ul style="list-style-type: none"> <li>● Open lab for preparation of Midterm demo (on non-lab days)</li> <li>● Deadline of Mechanical Homework 2 (on Oct 15, 2013)</li> </ul>
8	21/10	Digital Logic (1) + <b>MC Quiz (1)</b>	Lab 4: Sensing and Actuator	<ul style="list-style-type: none"> <li>● <b>Midterm demo</b> (a soldered and working control board and a car that can go in straight line)</li> <li>● Release of project details/specification for demo-1 and demo-2</li> </ul>
9	28/10	Digital Logic (2)	Lab 5: Digital Logic (1)	<ul style="list-style-type: none"> <li>● Preparation of quiz (2)</li> </ul>
10	4/11	Digital Logic (3) + Project Briefing + <b>MC Quiz (2)</b>	Lab 6: Digital Logic (2)	
11	11/11		Car development + Mentor Meeting (1)	
12	18/11		Car development + Mentor Meeting (2)	
13	25/11	Briefing on final report	Car development + Mentor Meeting (3) + Demo-1	
14 (extra)	2/12		Demo-1 + Demo-2 (optional; for getting A &A-)	<ul style="list-style-type: none"> <li>● Demo-1 continued on 2/12</li> <li>● Demo-2 on 3/12</li> <li>● Deadline of project report: Dec. 09, 2013</li> </ul>

### Important dates to note:

1. **Week 1: group forming.** Find a peer to form a group with you. The group size is 2. Make sure your partner is registered to the **same lab session** as yours. You are required to register with your partner using the CU eLearning System. Group sign up procedure is provided to you in the "Elearn information.pdf" document in eLearn. You must sign up by **6 Sep. 2013 (Friday)**; otherwise, you will be randomly assigned to a partner.
2. **All the homework deadlines are at 5:30pm of the listed dates.**
3. **Week 14: submission of the final project report.** The deadline is on **Dec. 9, 2013 (Monday), at 5:30pm.**

### 3 Assessment

Item	%	Detailed Information
Lab Assignments (24) + Homework (6)	30%	<ul style="list-style-type: none"><li>• 4 marks x 6 labs (from lab 1 to lab 6) = 24</li><li>• For each lab session, 1 mark will be deducted for students who fail to attend lab session on time (15-min grace period)</li><li>• 3 marks per homework</li></ul>
MC Quizzes	2x5%= 10%	<ul style="list-style-type: none"><li>• 2 x 15-min. multiple choice quiz covering the contents taught in lectures</li></ul>
Mid-term Test Run	10%	<ul style="list-style-type: none"><li>• Demonstrate a car that can go in a straight line and properly soldered control board</li></ul>
Project Progress	3x5%= 15%	<ul style="list-style-type: none"><li>• Report your project progress to mentor</li><li>• Assessed by your project mentor and TA</li><li>• Mentor meeting once a week during implementation phase (Week 10-12)</li><li>• <i>Attendance is counted; 5% deduction for each absence (individual)</i></li></ul>
Demo-1	10%	<ul style="list-style-type: none"><li>• Demonstrate your robot for the basic function of collecting a soda can and drop off at destination</li><li>• Assessed by course coordinator/mentors</li></ul>
Demo-2 (optional; only for students who want to get A and A-)	15%	<ul style="list-style-type: none"><li>• Demonstrate your AGCs for advanced features</li><li>• Assessed by a judge panel</li></ul>
Final Report	10%	<ul style="list-style-type: none"><li>• Deadline: 5:30pm, Dec. 9 (Mon)</li></ul>
<b>Total</b>	<b>100%</b>	

### 4 Learning Outcomes

After participating in this design project, together with the associated lectures and laboratory sessions, we expect you to be able to

1. *Understand basic mechanical design, electronics principles and appreciate their importance;*
2. *Gain basic engineering skills on the use of CAD software, instrumentation, hardware construction and testing;*
3. *Understand engineering design processes and systematic approaches to solving engineering problems;*
4. *Learn teamwork by working and communicating with your peer as a team towards milestones.*

## 5 General Course Information

Item	Information			
Lectures	Weeks 1-9 & 13 ( <i>except week 1</i> ) Class:           ENGG1100A                         ENGG1100B Time:            Mon 8:30am-9:15am            Mon 11:30am-12:15pm Venue:          Lecture Theatre, 9/F,            LT5, Lee Shau Kee Building William MW Mong               (LSK LT5) Engineering Building (ERBLT)			
Laboratories (All Weeks)	<i>Session</i>	<i>Lab</i>	<i>Time</i>	
	ENGG1100AL-01	ERB1103, 11/F, William MW Mong Engg Building	Mon 9:30-12:15am	
	ENGG1100AL-02	SHB114, 1/F, Ho Sin Hang Engg Building	Mon 9:30-12:15am	
	ENGG1100AL-03	SHB102, 1/F, Ho Sin Hang Engg Building	Mon 9:30-12:15am	
	ENGG1100BL-01	ERB1103, 11/F, Ho Sin Hang Engg Building	Mon 1:30-4:15pm	
	ENGG1100BL-02	SHB114, 1/F, Ho Sin Hang Engg Building	Mon 1:30-4:15pm	
Course Website	In eLearn, see <a href="https://elearn.cuhk.edu.hk">https://elearn.cuhk.edu.hk</a>			
Course Inquiry	Please send all your inquiries to <a href="mailto:engg1100@erg.cuhk.edu.hk">engg1100@erg.cuhk.edu.hk</a>			
Course Coordinators	<i>Name</i>	<i>Dept.</i>	<i>Email</i>	
	Prof. Calvin CK Chan (AL01, BL01)	IE	ckchan@ie.cuhk.edu.hk	
	Prof. K.H. Wong (AL03)	CSE	khwong@cse.cuhk.edu.hk	
	Prof. Y.H. Liu (AL02, BL02)	MAE	yhliu@mae.cuhk.edu.hk	
Course Mentors	<i>Section</i>	<i>Name</i>	<i>Dept.</i>	<i>Email</i>
	AL01	Professor ZHANG Kehuan	IE	<a href="mailto:khzhang@ie.cuhk.edu.hk">khzhang@ie.cuhk.edu.hk</a>
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		DR TSE Kam Hon	IE	<a href="mailto:khtse@ie.cuhk.edu.hk">khtse@ie.cuhk.edu.hk</a>
	AL02	DR LEUNG Suk Wai Winnie	MAE	<a href="mailto:wsweung@mae.cuhk.edu.hk">wsweung@mae.cuhk.edu.hk</a>
		Professor ZHANG Li	MAE	<a href="mailto:lizhang@mae.cuhk.edu.hk">lizhang@mae.cuhk.edu.hk</a>
		Professor LU Yi-Chun	MAE	<a href="mailto:yichunlu@mae.cuhk.edu.hk">yichunlu@mae.cuhk.edu.hk</a>
	AL03	Professor XU Qiang	CSE	<a href="mailto:qxu@cse.cuhk.edu.hk">qxu@cse.cuhk.edu.hk</a>
		Professor WONG Kin Hong	CSE	<a href="mailto:khwong@cse.cuhk.edu.hk">khwong@cse.cuhk.edu.hk</a>
		Professor WU Yu Liang	CSE	<a href="mailto:ylwu@cse.cuhk.edu.hk">ylwu@cse.cuhk.edu.hk</a>
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	BL01	Professor Sidharth JAGGI	IE	<a href="mailto:jaggi@ie.cuhk.edu.hk">jaggi@ie.cuhk.edu.hk</a>
		Professor CHEN Minghua	IE	<a href="mailto:mhchen@ie.cuhk.edu.hk">mhchen@ie.cuhk.edu.hk</a>
		Professor ZHANG Kehuan	IE	<a href="mailto:khzhang@ie.cuhk.edu.hk">khzhang@ie.cuhk.edu.hk</a>
	BL02	Professor LIU Yunhui	MAE	<a href="mailto:yhliui@mae.cuhk.edu.hk">yhliui@mae.cuhk.edu.hk</a>
		Professor CHEN Shih Chi DR LEUNG Suk Wai Winnie	MAE MAE	<a href="mailto:schen@mae.cuhk.edu.hk">schen@mae.cuhk.edu.hk</a> <a href="mailto:wsweung@mae.cuhk.edu.hk">wsweung@mae.cuhk.edu.hk</a>

Lecturers	Prof. K. H. Wong (CSE) Prof. Ken Ma (EE) Prof. Calvin C.K. Chan (IE) Prof. Y. H. Liu (MAE) Prof. Helen Meng (SEEM)
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## 6 Laboratory

1. Laboratory safety is very important! Strict observation of the Laboratory Safety Instructions listed in the homepage (<http://www.cuhk.edu.hk/useo/>) of the University Safety & Environment Office on the handling of electrical and electronic instruments and power sources is mandatory.
2. Please don't eat or drink in the laboratory.
3. Be punctual. Attendance will be checked, and 1 mark will be deducted for those who are late for more than 15 minutes.
4. Laboratory preparation is vital for you to conduct the lab works. Prior to each lab, please
  - a. **read the lab manual;**
  - b. **prepare lab sheet according to the lab manual;** and
  - c. **bring the lab sheet to the lab with you.**
5. The laboratory provides you with all the equipment required to implement your project. If you want to use the lab outside your lab sessions, you may be allowed to do so with the permission from the technicians.
6. There are components and hardware available in the lab; they are definitely sufficient to build an intelligent car (with a good working condition). If you want some special components, please consult our technicians. In case the lab does not have components you requested, you may purchase them yourselves and then apply for reimbursement. The budget is HK\$200 for each group. Requirement: (1) you must give us a justification why they are needed; (2) receipts are available; and (3) you show that you do have used those components in your final prototype.

## 7 Plagiarism and Academic Honesty

As a CUHK student, you are respectfully requested to observe and acknowledge the academic honesty in academic works, which is the core value of higher learning. This value together with plagiarism monitoring held here at CUHK and elsewhere in academic institutes and professional societies will guide you to accomplish your academic and professional works in a fair, honesty, and cherishable manner.

CUHK has clear definitions and guidelines on academic honesty. In addition, the Faculty of Engineering has provided discussions and examples of plagiarism in "computer" programming and lab report, making use of results from "discussions with fellow students," making use of materials from Internet, as well as penalty scheme for plagiarism. Please see the following two documents for the details. We adopt a policy of zero tolerance on plagiarism. Disciplinary actions, usually involving severe penalties, will be taken for detected plagiarism cases.

1. "[Guidelines to Academic Honesty](http://www.erg.cuhk.edu.hk/erg-intra/upload/documents/ENGG_Discipline.pdf)," Faculty of Engineering, CUHK, August 2012, [http://www.erg.cuhk.edu.hk/erg-intra/upload/documents/ENGG\\_Discipline.pdf](http://www.erg.cuhk.edu.hk/erg-intra/upload/documents/ENGG_Discipline.pdf)
2. "[Honesty in Academic Work: A Guide for Students and Teachers](http://www.cuhk.edu.hk/policy/academichonesty/)," CUHK, August 2012, <http://www.cuhk.edu.hk/policy/academichonesty/>

## 8 Student / Faculty Expectations on Teaching and Learning

Learning process in university environment is an interactive engagement between faculty members and the student body. The Faculty of Engineering has always placed a strong emphasis on quality teaching and learning.

With a view to building up an atmosphere of mutual respect, acknowledgement, and responsibility between our students and faculty members as well as to enhancing teaching and learning in the Faculty, the Faculty has worked out a document on “Student/Faculty Expectations on Teaching and Learning” in consultation with our students and teachers, which clearly establishes a balanced set of expectations for the students and faculty members of our Faculty.

- “Student/Faculty Expectations on Teaching and Learning,”  
Faculty of Engineering, CUHK, 29 August 2011,  
<http://www.erg.cuhk.edu.hk/erg-intra/upload/documents/StaffStudentExpectations.pdf>

With this document, we believe that both of our students and faculty members could be well aware of the mutual expectations on teaching and learning of each other, which would help in driving their efforts with our ultimate goal of achieving and up-keeping quality teaching and learning in the Faculty.

Finally, we hope you will enjoy this course and the process of going through Engineering Design together.